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FINAL REPORT

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BLIGHT DISEASE OF CORIANDER AND CARAWAY

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Final Report for Saskatchewan Agricultural Development Fund Project 19990339

'Blight Disease of Coriander and Caraway' for January 1, 2003

(a) Abstract/Summary

The browning and death of growing tips, flowers, umbels, to extensive dieback of shoots occurs on coriander and caraway. *Aureobasidium* sp. was the major cause of blight on coriander, and *Ascochyta* sp. on caraway. Other fungi can cause blight and most will also affect cumin, anise and dill. Losses up to 95% occurred in 2000 when moist conditions occurred during flowering. A Quadris trial in caraway in 2002 showed obvious control but later there was no difference in disease or yield as the disease spread into sprayed areas. Suggested control includes using crop rotation and not continuously cropping. No fungicides are registered.

(b) Executive Summary

In Saskatchewan, coriander and caraway are affected by a disease that causes the browning and death of growing tips, flowers, umbels, to extensive dieback of shoots. Severe losses can occur if wet conditions occur during flowering.

Causal Agents on Caraway and Coriander. Results from growth room tests where flowering plants were inoculated with various organisms showed many fungi are capable of causing blight. However, the most important cause of blight in caraway is an *Ascochyta* sp., while in coriander it is an *Aureobasidium* sp. *Ascochyta* sp. can also cause blight on coriander while *Aureobasidium* sp. can cause blight on caraway. Additional fungal species caused blight on both crops and these were: *Fusarium avenaceum, F. poae, F. culmorum, F. equiseti, F. sporotrichioides, F. graminearum, Botrytis cinerea* and an unknown non-sporulating fungus. There are reports from elsewhere indicating *Sclerotinia sclerotiorum* can cause blight but this fungus was not assessed in this study. The occurrence of persistent wet conditions during flowering could result in any one of these fungi causing blight.

Effect of Fungi on Cumin, Anise and Dill. Flowering plants of these three crops were inoculated in a growth room with the pathogenic fungi that cause blight on caraway and coriander. Flower blight developed on cumin with all pathogens with lots of symptoms occurring with *Fusarium avenaceum, F. culmorum, F. sporotrichioides* and *Botrytis cinerea*. Few symptoms occurred with *Aureobasidium* sp., *Ascochyta* sp., *Fusarium poae, F. equiseti* and *F. graminearum*. This indicates that all fungi which cause blight on caraway and coriander also cause blight on cumin.

On anise, lots of symptoms occurred with *Aureobasidium* sp., *Ascochyta* sp., *Fusarium culmorum* and *F. sporotrichioides*, while few symptoms occurred with *F. avenaceum, F. equiseti* and *F. graminearum*. This indicates that these fungi are pathogenic on anise. No symptoms occurred with *Botrytis cinerea* and *Fusarium poae* which indicates these two fungi are non-pathogenic on anise.

On dill, lots of symptoms occurred with *Fusarium culmorum* and *F. sporoticihioides*, while few symptoms occurred with *F. avenaceum*. This indicates that these three fungi are pathogenic on dill. No symptoms, indicating a non-pathogenic reaction, occurred with *Aureobasidium* sp., *Ascochyta* sp., *Botrytis cinerea, Fusarium poae, F. equiseti* and *F. graminearum*.

Disease Surveys on Caraway. Surveys were done from 2000 to 2002 when plants in fields were in mid- to full-flower and if the disease was present it was caused by *Ascochyta* sp. Blight was most severe in 2000 because of the moist conditions that occurred during flowering. Between 1 to 10% of plants were affected in fields at Prince Albert, Albertville, Domremy and Naicam. In two fields at Birch Hills 80 to 95% of the plants were diseased while at Gerald, fields were 50 to 80% damaged. Severely affected fields tended to be older, that is, at least three years old in the second year of seed production, but there were exceptions like the 50% damaged two-year-old field at Gerald. Some fields showed distinct patches of disease indicating points of inoculation that may have originated from seed. In 2001 and 2002 blight was only found in the same field at Gerald. In 2001, the disease was present in trace amounts but in 2002, this now three-year-old field, had 80% blighted plants. Drought stress was widespread in the province in 2001 and 2002. Aster yellows occurred in all years but usually only at trace amounts, except for

one field in 2000 at Imperial which had 20% infected plants, and one field in 2001 at Paddockwood which had 50% infected plants.

Disease Surveys on Coriander. Surveys were done from 2000 to 2002 when plants in fields were in mid- to full-flower. In 2000, none or up to 5% blight infection, caused by *Aureobasidium* sp., was found at Annaheim, Nokomis, Gerald, Prince Albert, Imperial, Lucky Lake, Eston and Loreburn. Forty to 60% infection was found at Albertville and Prince Albert. Some fields showed distinct patches of disease indicating points of inoculation that may have originated from seed. In 2001 and 2002 drought affected most of the areas in which coriander was grown and no blight was found in 2001. In 2002, there was a trace of disease at Gerald but it was caused by *Ascochyta* sp. likely because it was next to a severely blighted field of caraway where the disease was caused by *Ascochyta* sp. Aster yellows occurred in all years in some fields but only at trace amounts.

Assessment of Quadris for Blight Control. Fungicides were assessed for control of blight but with limited success. In 2000, a small plot test was done in a coriander field but dry conditions occurred after spraying so no further disease development occurred so the test was not useful. Drought conditions in 2001 and 2002 limited the ability to test the use of fungicides for control of blight. Quadris, a systemic and broad spectrum fungicide, registered for use on canola and chickpea, was tested at one location at Gerald in a field of caraway in 2001. A spray strip was applied at 200 mL of product per acre when plants were in early flower. At mid-flower, the unsprayed crop had about 0.1% of plants with blight while in the sprayed area blight occurred at trace amounts (<0.1% of plants affected). In spite of the low level of disease, an area 25 feet wide by 1320 feet long (0.3 ha) was harvested from the sprayed area and from an adjacent parallel unsprayed area. The yield was 375 kg (1049 lbs/acre) from the unsprayed area and 405 kg (1133 lbs/acre) from the sprayed area.

On June 24, 2002, the same caraway field, now a three-year-old field was sprayed with Quadris as in 2001 but as four strips with unsprayed strips in-between. Conditions favoured disease development and on July 2 the unsprayed area had about 80% blighted flowers caused by *Ascochyta* sp. while the sprayed area had 10% blighted flowers. There was an obvious visual difference between the sprayed and the unsprayed areas but about a week to 10 days later there was no obvious difference between the treatments as the disease spread in the sprayed areas. Areas 25 feet wide by 1430 feet long (0.82 acre or 0.33 hectare) were harvested. There was no difference (P=0.69) in the yield between the unsprayed check (78 lbs/acre or 235 kg/hectare) and sprayed areas (96 lbs/acre or 289 kg/hectare). Without the disease it was estimated that the field would have yielded at least 800 lbs/acre.

The results show Quadris provides short term control but for effective control multiple spray applications will likely be required. Quadris is not registered for use on caraway and coriander and its use is not recommended. If residue of the chemical is found on harvested seed, the seed will not be able to be sold.

Suggested Control Measures. There is no silver bullet for the control of blight on coriander and caraway. The currently grown types or cultivars show no resistance to blight. A prolonged moist period during flowering is very conducive to disease development. This occurred in 2000 where losses of up to 95% occurred in some crops.

The risk of disease usually increases the year following a severe disease year, the longer you have been growing these crops, and the longer the period of continuous cropping of coriander or caraway. During this study, blight was usually more severe in fields where a crop had been grown continuously for several years. Once the disease is established the risk of severe damage is high, for instance, if caraway is grown for more than two years when the disease was found in the field in the second year. The common practise of underseeding coriander with caraway could favour disease development in caraway when it produces seed the following year because the same pathogens can affect both crops. Crop rotation is another control measure but there is no data to suggest how long the interval should be between crops. A guess would be a 2 to 5 year period between the same crop. There are many factors that determine how long the causal agents will survive in a field. For instance, coriander persists as a weed for a long time, which could allow the disease to survive in a field so a longer interval between crops, may be needed. Another consideration is that the fusaria, which can cause blight in coriander and caraway, also cause fusarium head blight in wheat. So if fusarium head blight was severe in a wheat field it might be appropriate that this field not be seeded to coriander or caraway the following year. A severely diseased coriander or caraway crop is a source of inoculum for crops planted in adjacent fields so a severely infected quarter section has the potential to spread the disease to any of the adjacent eight quarters in the next cropping season. Using a seed source from a field with no disease should reduce the spread to new fields or new areas. Caraway seed could be tested for the presence of pathogens but coriander seed is usually heavily contaminated with saprophytes so a seed test may be inconclusive to measure the presence of pathogens. Although fungicides sprays have shown some promise none are registered for use on these crops.

(c) Technical Report

Project Objective: To identify the causal agent of the blight disease of coriander and caraway, and to assess methods of controlling this disease.

1. Identification of the Cause of These Diseases

Isolation of Organisms and Assessment on Caraway and Coriander. In Saskatchewan, coriander and caraway are affected by a disease that causes the browning and death of growing tips, flowers, umbels, to extensive dieback of shoots. Severe losses can occur if wet conditions occur during flowering.

One objective was to determine the causal agent of blight. Naturally infected plant material collected from fields was incubated for 4 to 6 days in a moist chamber, then a suspension from this material was sprayed on flowering plants grown in a growth chamber. For coriander, diseased plants came from Eston, Elrose, and Prince Albert in 1999 and from Eston in 2000, while for caraway they came from Birch Hills in 2000. Inoculated plants were enclosed in a plastic bag for 4 to 6 days. After this time if symptoms occurred similar to those observed in the field, the diseased tissue was used to isolate organisms in pure culture. Fresh tissue was disinfected in a 10% bleach solution and then plated on various media. Koch's postulates was followed to determine if any of the isolated organisms were the cause of the disease. The process involved inoculating pots of flowering plants grown in a growth chamber with aqueous suspensions from cultures of the organisms isolated from diseased tissue. If symptoms developed, the cause of the disease was confirmed by reisolating the organism from the diseased tissue that was used to do the inoculation. For organisms that were pathogenic, the procedure for inoculation, symptom production, and reisolation, were repeated at least three times. In addition, several *Fusarium* sp. obtained from Robin Morrall were assessed for the ability to cause blight.

Results from growth room tests where flowering plants were inoculated with various organisms showed many fungi were capable of causing blight. However, the most important cause of blight in caraway was an *Ascochyta* sp., while in coriander it was an *Aureobasidium* sp. *Ascochyta* sp. also caused blight on coriander while *Aureobasidium* sp. caused blight on caraway. Additional fungal species caused blight on both crops and these were: *Fusarium avenaceum, F. poae, F. culmorum, F. equiseti, F. sporotrichioides, F. graminearum, Botrytis cinerea* and an unknown non-sporulating fungus. *Fusarium avenaceum* and the non-sporulating fungus were isolated from infected tissue. There are reports from elsewhere indicating *Sclerotinia sclerotiorum* can cause blight but this fungus was not assessed in this study. The occurrence of persistent wet conditions during flowering could result in any one of these fungi causing blight. Although there is one fungus which is the major cause of the disease in each crop, growers in an area where fusarium head blight of wheat is a problem could have one or several of the fusaria species cause blight in caraway or coriander. All the *Fusarium* spp. can be associated with fusarium head blight of cereals, and several fusaria cause a root rot of canola and lentil.

Many other fungi and bacteria were isolated and assessed but they did not cause blight. One *Alternaria alternata* isolate caused some discoloration of blossoms and this fungus could possibly cause some minor damage if a very extensive wet period occurred during flowering. This fungus is a widespread saprophyte that grows on senescing tissue or tissue that has been killed by a pathogen. Its growth on diseased tissue in blighted crops contributes to the darkening that makes blighted crops so obvious compared to healthy crops.

Information from other countries indicate two pathogens occur on coriander, one being the fungus *Colletotrichum gloeosporioides* (telemorph, *Glomerella cingulata*), and the other the bacteria *Pseudomonas syringae* pv. *coriandricola*. Both these pathogens have caused severe damage to coriander but so far they have not been found in Saskatchewan. On caraway, in other countries, two *Ascochyta* sp. and the fungus, *Phomospsis diachenii*, are known pathogens.

The main causal agents, *Aureobasidium* sp. in coriander and *Ascochyta* sp. in caraway, are extremely difficult to isolate from diseased tissue. They are slow growing and easily overgrown by the numerous and varied saprophytes that are present in blighted tissue. *Aureobasidium* sp. was isolated by plating disinfected small pieces of recently blighted tissue on water agar. The sparse growth of fungi on water agar allows one to see under the microscope the characteristic growth of *Aureobasidium* sp. which is whorls of budding spores on hyphae. The fungus can then be transferred to potato dextrose agar where it produces a slimy bacteria-like growth which covers the plate in about two weeks. In caraway, the pycnidia which are the sporulating structures of *Ascochyta*, are abundant in diseased flower parts. However, this fungus is difficult to isolate from diseased tissue.

In 2002, diseased caraway residue collected from Gerald was used to initiate blight in a plot of annual caraway at the University of Saskatchewan. Pycnidia and spores of *Ascochyta* sp. were present in large numbers in this residue and the diseased tissue in the plots also contained pycnidia and spores of *Ascochyta* sp. Blight was initiated in coriander plots by spraying parts of the area with a spore suspension of *Aureobasidium* sp. when plants were flowering. *Aureobasidium* sp. was recovered from diseased plants taken from the plot.

Effect of Fungi on Cumin, Anise and Dill. An additional objective was added to the original agreement which was to determine if the pathogens which cause blight on caraway and coriander might also affect cumin, anise, and dill. Flowering plants of these three crops were inoculated in a growth room with the pathogenic fungi that cause blight on caraway and coriander. Flower blight developed on cumin with all pathogens with lots of symptoms occurring with *Fusarium avenaceum*, *F. culmorum*, *F. sporotrichioides* and *Botrytis cinerea*. Few symptoms occurred with *Aureobasidium* sp., *Ascochyta* sp., *Fusarium poae*, *F. equiseti* and *F. graminearum*. This indicates that all fungi which can cause blight on caraway and coriander can also cause blight on cumin. It is unknown if this occurs in the field. Cumin is rarely grown because of poor seed production that is suspected to be due to blight. No blight was observed in a plot of cumin grown in Saskatoon in 2002.

On anise, lots of symptoms occurred with *Aureobasidium* sp., *Ascochyta* sp., *Fusarium culmorum* and *F. sporotrichioides*, while few symptoms occurred with *F. avenaceum*, *F. equiseti* and *F. graminearum*. This indicates that these fungi are pathogenic on anise. No symptoms occurred with *Botrytis cinerea* and *Fusarium poae* which indicates these two fungi are non-pathogenic on anise. It is unknown if this occurs in the field. A field in the Eston area in 2000 was not affected by blight.

On dill, lots of symptoms occurred with *Fusarium culmorum* and *F. sporoticihioides*, while few symptoms occurred with *F. avenaceum*. This indicates that these three fungi are pathogenic on dill. No symptoms, indicating a non-pathogenic reaction, occurred with *Aureobasidium* sp., *Ascochyta* sp., *Botrytis cinerea*, *Fusarium poae*, *F. equiseti* and *F. graminearum*. It is unknown if this occurs in the field. No blight was found in dill in fields at Prince Albert and Gerald in 2000, and in a field at Gerald in 2001.

2) Disease Surveys

Caraway. In 2000, 20 fields at 11 grower locations were surveyed between June 22 to July 24 when plants were in mid- to full-flower. Caraway blight, caused by *Ascochyta* sp., was not found or was at low levels at Moose Jaw, Imperial, Nokomis and Paddockwood. The disease was between 1 to 10% at Prince Albert, Albertville, Domremy and Naicam. Several fields were observed at Birch Hills and some had no disease or traces of blight to two fields where 80 to 95% of the plants were diseased. At Gerald, fields were 50 to 80% damaged. Severely affected fields tended to be older, that is, at least three years old in the second year of seed production, but there were exceptions like the 50% damaged second year field at Gerald. Some fields showed distinct patches of disease indicating foci of infection which may have originated from seed. There were also some excellent stands. High levels of disease were associated with a prolonged moist period during flowering. Aster yellows was present in all fields at low levels except for one field at Imperial were levels were estimated to be about 20% infected plants.

In 2001, 22 fields at 14 locations were surveyed between June 22 to 29 when plants were in mid- to full-flower. Caraway blight, caused by *Ascochyta* sp., was only found at a low level in one field at Gerald. Aster yellows was present in almost all fields at low levels except for one field at Paddockwood, a three-year-old field, that had about 50% infected plants. Drought stress was the major problem elsewhere which included fields in the Prince Albert, Naicam, and Elstow to Nokomis areas.

In 2002, 11 fields at eight grower locations were surveyed July 2 and 3 when plants were in full bloom to advanced blooming. There were two two-year-old crops (first year seed fields) and nine three-year-old crops (second year seed fields). Ten fields had no blight but high levels of blight, with 80% of plants affected, caused by *Ascochyta* sp., occurred at Gerald in a three-year-old crop. Drought stress was the major problem elsewhere which included fields in the Paddockwood to Prince Albert areas as well as near Lanigan and Nokomis. A trace of aster yellows occurred in four fields at Birch Hills, Pathlow, Nokomis, and Gerald.

Coriander. In 2000, 22 fields at 12 grower locations were surveyed between July 24 to 26 when plants were in mid- to full-flower. None or up to 5% blight infection, caused by *Aureobasidium* sp., was found at Annaheim, Nokomis, Gerald, Prince Albert, Imperial, Lucky Lake, Eston and Loreburn. Forty to 60% infection was found at Albertville and Prince Albert. Blight showed up in many fields as distinct patches. At one location near Prince Albert this likely originated from seed as they had never grown the crop before and nor was, or had there been, any

coriander grown nearby. One of their fields had about 50% disease but all the rest showed 1 to 5 m^2 patches which covered 1 to 5% of the field. Some fields in other locations showed the effect of spread from a previous nearby crop. The whole section field at Imperial had the disease as a streak about 50 m wide in one patch which was a wet area in the spring. Aster yellows was present in all fields at low levels.

In 2001, five fields at four grower locations (St. Denis, Nokomis, Imperial, Gerald) were surveyed between July 19 to 23 when plants were in mid- to full-flower. No blight was found in any fields. Aster yellows was present at trace levels in one field near Nokomis. Drought stress was the most important problem. Due to the drought, other areas of the province were not surveyed.

In 2002, 12 fields at eight grower locations were surveyed from July 18 to 24 when plants were in mid- to full-flower. A trace of blossom blight occurred in the field at Gerald. This was caused by *Ascochyta* sp. likely because it was next to a severely blighted field of caraway where the disease was caused by *Ascochyta* sp. Other areas in the survey were fields near Assiniboia, Loreburn, and Lucky Lake. There was a trace of aster yellows in two fields at Imperial and Gerald.

3. Assessment of control measures.

2000 Assessment of Bravo and Copper Oxychloride on Coriander blight. This test was done in a commercial field of coriander at Eston. Two, 2 x 12 meter strips of three treatments were done. This included 1) Copper oxychloride 50% WP at 3.95 kg/ha with 140 L of water sprayed on July 13 and July 20, 2) one application of Bravo (chlorothalomil 500 g/L) at 3 L/ha with 140 L of water on July 13, and 3) two applications of Bravo sprayed on July 13 and July 20. On August 31, one meter square matching plots, one from the sprayed area and one immediately beside it were harvested. There were eight matching plots per treatment. The plants were dried, then threshed and the seed weighed. The results appear below. There was no effect of treatment. Although the disease caused by *Aureobasidium* sp. was present early, there was no further development of blight in the field because of the dry weather conditions. So this was not a good test to assess the value of these products in controlling coriander blight.

		Mean yield per square meter	Significance
Treatment 1	copper oxychloride	116 g	n.s. (P=0.06)
	unsprayed check	130 g	
Treatment 2	Bravo - one application	130 g	n.s. (P=0.08)
	unsprayed check	122 g	
Treatment 3	Bravo - two applications	116 g	n.s. (P=0.08)
	unsprayed check	126 g	

2001 Assessment of Quadris for Caraway and Coriander Blight. Drought conditions in 2001 limited the testing of fungicides for control of blight. Quadris, a systemic and broad spectrum fungicide, registered for use on canola and chickpea, was only tested at the one location where some disease occurred in 2001. At Gerald, a spray strip was applied at 200 mL of product per acre, in a field of caraway on June 17, 2001 and a field of coriander when these crops were in early flower. No disease developed in coriander so nothing further was done with coriander. In caraway, at mid-flower, the unsprayed crop had about 0.1% of plants with blight caused by *Ascochyta* sp. while in the sprayed area blight occurred at trace amounts (<0.1% of plants affected). This field had been seeded on May 24, 1999. On August 9, 2001 the field was swathed and on August 19, 2001 an area 25 feet wide by 1320 feet long (0.3 hectare) was combine harvested from the sprayed area and from an adjacent parallel unsprayed area. The yield was 375 kg/hectare (1049 lbs/acre) from the unsprayed area and 405 kg/hectare (1133 lbs/acre) from the sprayed area.

These are encouraging results but additional testing needs to be done. Quadris is not registered for use on caraway and coriander and its use is not recommended. If residue of the chemical is found on harvested seed, the seed will not be able to be sold.

This research was possible because of the co-operation of Brian Petracek who did all the work in his field where the test was done. Rod Lessmeister of Syngenta provided the chemical for the study.

2002 Assessment of Quadris for Caraway Blight. Drought conditions in 2002 limited the testing of fungicides for control of blight. The only promising site where disease occurred in 2002 was at Gerald where Quadris, a systemic and broad spectrum fungicide, registered for use on canola and chickpea, was tested. Four parallel strips were sprayed on June 24 when the plants were in early bloom using 200 mL of product per acre. There were unsprayed strips between the sprayed strips. This was the same field of caraway used in 2001 so it was a three-year-old field in the second year of seed production. Conditions favoured disease development and on July 2 the unsprayed area had about 80% blighted flowers caused by *Ascochyta* sp. while the sprayed area had about 10% blighted flowers. There was an obvious visual difference between the sprayed and the unsprayed areas but about a week to 10 days later there was no obvious difference between the treatments as the disease spread in the sprayed areas. On August 8 the field was swathed and on September 8 the centre of the four sprayed strips and four parallel strips in adjacent unsprayed areas were combined. The strips were 25 feet wide by 1430 feet long (0.82 acre or 0.33 hectare). There was no difference (P=0.69) in the yield between the unsprayed check (78 lbs/acre or 235 kg/hectare) and sprayed areas (96 lbs/acre or 289 kg/hectare). Without the disease it was estimated that the field would have yielded at least 800 lbs/acre.

The results show Quadris provides short term control but for effective control multiple spray applications will likely be required. Quadris is not registered for use on caraway and coriander and its use is not recommended. If residue of the chemical is found on harvested seed, the seed will not be able to be sold.

This research was possible because of the co-operation of Brian Petracek who did all the work in his field where the test was done. Rod Lessmeister of Syngenta provided the chemical for the study.

Suggested Control Measures. There is no silver bullet for the control of blight on coriander and caraway. The currently grown types or cultivars show no resistance to blight. A prolonged moist period during flowering is very conducive to disease development. This occurred in 2000 where losses of up to 95% occurred in some crops.

The risk of disease usually increases the year following a severe disease year, the longer you have been growing these crops, and the longer the period of continuous cropping of coriander or caraway. During this study, blight was usually more severe in fields where a crop had been grown continuously for several years. Once the disease is established the risk of severe damage is high, for instance, if caraway is grown for more than two years when the disease was found in the field in the second year. The common practise of underseeding coriander with caraway could favour disease development in caraway when it produces seed the following year because the same pathogens can affect both crops. Crop rotation is another control measure but there is no data to suggest how long the interval should be between crops. A guess would be a 2 to 5 year period between the same crop. There are many factors that determine how long the causal agents will survive in a field. For instance, coriander persists as a weed for a long time, which could allow the disease to persist in a field so a longer interval between crops, may be needed. Another consideration is that the fusaria, which can cause blight in coriander and caraway, also cause fusarium head blight in wheat. So if fusarium head blight was severe in a wheat field it might be appropriate the field not be seeded to coriander or caraway the following year. A severely diseased coriander or caraway crop is a source of inoculum for crops planted in adjacent fields so a severely infected quarter section has the potential to spread the disease to any of the adjacent eight quarters in the next cropping season. Using a seed source from a field with no disease should reduce the spread to new fields or new areas. Caraway seed could be tested for the presence of pathogens but coriander seed is usually heavily contaminated with saprophytes so a seed test may be inconclusive to measure the presence of pathogens. Although fungicides sprays have shown some promise none are registered for use on these crops.

(d) Personnel- Consultant - Lorne Duczek

(e) Equipment- None purchased

(f) Project Developed Materials- An abstract summarising the research will be submitted for publication in the Canadian Journal of Plant Pathology. A copy is attached as Addendum I. Two reports on various aspects of the study relating to disease surveys will be published in the 2003 Canadian Plant Disease Survey - volume 83. Copies

are attached as Addendum II-III. A one page extension brochure was produced and it is attached to the hard copy of this report as Addendum IV. A detailed summary of the study was sent to grower cooperators and to interested extension persons in Saskatchewan, Manitoba and Alberta.

(g) Project Photos- Photos of disease symptoms were taken and were used in presentations. A CD containing the best photos was given to P. Pearse/ R. McVicar.

(h) Acknowledgements- In any reports or summaries the support of ADF- Saskatchewan Department of Agriculture and Food was mentioned. An update on the project was presented at the Herb and Spice Conference in Saskatoon on January 12, 2001 and January 10, 2002, and a final report will be presented on January 9, 2003. A workshop was also done on January 12, 2001. On December 4, 2002 a presentation on this research was made to the Saskatchewan Regional Group of the Canadian Phytopathological Society in Saskatoon. A verbal report on the disease survey in 2000 was given at the Plant Disease Sub-Council meeting in Saskatoon on November 27, 2000. At a Spice Update meeting in Eston on April 3, 2001, a talk was given relating to this research. A talk on the same subject was given at the Saskatchewan Nutraceutical and Functional Food Research Update on April 5, 2001 in Saskatoon.

The co-investigator in this study was Dr. A.E. Slinkard, Department of Plant Science, 51 Campus Drive, University of Saskatchewan, Saskatoon, Saskatchewan, S7N 5A8.

Lorne Duczek December 13, 2002

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Addendum I

Blight of coriander and caraway in Saskatchewan 2000 to 2002. L.J. Duczek and A.E. Slinkard. *30 Birch Place, Saskatoon, SK S7N 2P6, Canada; and Department of Plant Science, 51 Campus Drive, University of Saskatchewan, Saskatoon, SK S7N 5A8, Canada.*

Blight of coriander and caraway causes a range of symptoms from the browning and death of growing tips, flowers, umbels, to extensive dieback of shoots. Kochs postulate and frequency of isolation indicated an *Aureobasidium* sp. was the major cause of blight on coriander, and *Ascochyta* sp. on caraway. These fungi, as well as *Fusarium avenaceum, F. poae, F. culmorum, F. equiseti, F. sporotrichioides, F. graminearum, Botrytis cinerea* and an unknown non-sporulating fungus also cause blight symptoms on both crops. These diseases were widespread in 2000 when moist conditions occurred during flowering and losses were as high as 95%. Three-year-old caraway fields were affected more than two-year-old fields. Some fields had distinct patches of blight that may have originated from seed. No disease occurred in drought stricken areas in 2001 and 2002. Quadris (azoxystrobin) application at early bloom in a caraway field showed obvious control after seven days with 10% disease in sprayed and 80% disease in unsprayed areas. Later, blight increased in sprayed areas and there was no difference in disease or yield. ADF-Saskatchewan Department of Agriculture and Food provided funding.

Addendum II

CROP: Caraway (*Carum carvi* L.)
LOCATION: Saskatchewan

NAMES AND AGENCIES:
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TITLE: BLIGHT OF CARAWAY IN SASKATCHEWAN FROM 2000 TO 2002

METHODS: Fields were surveyed each year when plants were in mid- to full-flower by walking in a 50-100 m circle. Disease incidence was based on the percentage of plants showing browning and death of growing tips, flowers, and umbels, to extensive dieback of shoots. The presence of aster yellows was also noted.

Samples of blighted tissue were collected to determine the cause of the disease. Small pieces of diseased tissue were surface disinfected in 0.6% NaOCl and plated on various media. Transfers were made onto potato dextrose agar to establish pure cultures. Koch's postulates were followed by inoculating pots of flowering plants from a growth chamber with aqueous suspensions from the cultures. Inoculated plants were enclosed in plastic bags for 4 to 6 days. If symptoms developed, the cause of the disease was confirmed by reisolating the organism. For organisms that were pathogenic, the procedure for inoculation, symptom production, and reisolation, were repeated at least three times. Several *Fusarium* sp. obtained from Robin Morrall were also tested for pathogenicity.

RESULTS AND COMMENTS: Koch's postulates and the frequency of isolation from infected plants collected in fields or the presence of a pathogen in infected tissue indicated an *Ascochyta* sp. was the major cause of blight in caraway. A species of *Aureobasidium*, which is the major cause of blossom blight in coriander, also caused blight on caraway, as did *Fusarium avenaceum, F. poae, F. culmorum, F. equiseti, F. sporotrichioides, F. graminearum, Botrytis cinerea* and an unknown non-sporulating fungus. *Fusarium avenaceum* and the unknown non-sporulating fungus were isolated from infected tissue. Pycnidia and conidia of *Ascochyta* were abundant in diseased flower parts but this fungus was extremely difficult to isolate from infected tissue.

In 2000, 20 fields at 11 locations were surveyed between June 22 and July 24. Blight, caused by *Ascochyta* sp., was not found or was at low levels at Moose Jaw, Lucky Lake, Imperial, Nokomis and Paddockwood. Disease incidence was between 1 and 10% at Prince Albert, Albertville, Domremy and Naicam. Several fields were observed at Birch Hills and some had no disease or traces of blight, but there were two fields where 80 to 95% of the plants were diseased. At Gerald, fields were 50 to 80% damaged. Severely affected fields tended to be older, that is, at least 3 years old and in the second year of seed production, but there were exceptions such as a 50% damaged 2-year-old field at Gerald. Some fields showed distinct patches of disease indicating foci of infection that may have originated from seed. High levels of disease were also associated with a prolonged moist period during flowering. Aster yellows was present in all fields at low levels, except for one field at Imperial which had about 20% infected plants.

In 2001, 22 fields at 12 locations were surveyed between June 22 and 29. Blight, caused by *Ascochyta* sp., was found only at a low level in one field at Gerald. Aster yellows was present in almost all fields at low levels, except for one 3-year-old field at Paddockwood that had about 50% infected plants. Drought stress was the major problem elsewhere, including fields in the Albertville, Meath Park, Prince Albert, Pathlow, Domremy, Birch Hills, Naicam, Elstow, Lanigan, and Nokomis areas.

In 2002, 11 fields at eight locations were surveyed between July 2 and 3. Ten fields had no blight but high levels of blight, caused by *Ascochyta* sp., with 80% infected plants occurred at Gerald in a 3-year-old crop. Traces of aster yellows occurred in four fields at Birch Hills, Pathlow, Nokomis, and Gerald. Drought stress was the major problem elsewhere, including fields in the Paddockwood, Meath Park, Naicam, and Lanigan areas.

ACKNOWLEDGEMENTS: Funding support was provided by the Agriculture Development Fund of the Saskatchewan Agriculture, Food and Rural Revitalization.

Addendum III

CROP: Coriander (*Coriandrum sativum* L.), Anise (*Pimpinella anisum* L.), Cumin (*Cuminum cyminum* L.), Dill (*Anethum graveolens* L.)
LOCATION: Saskatchewan

NAMES AND AGENCIES:
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TITLE: BLIGHT OF CORIANDER IN SASKATCHEWAN FROM 2000 TO 2002 WITH NOTES ON ANISE, CUMIN AND DILL

METHODS: Fields were surveyed each year when plants were in mid- to full-flower by walking in a 50-100 m circle. Disease incidence was based on the percentage of plants showing browning and death of growing tips, flowers, and umbels, to extensive dieback of shoots. The presence of aster yellows was also noted.

Samples of blighted tissue were collected to determine the cause of the disease. Small pieces of diseased tissue were surface disinfected in 0.6% NaOCl and plated on various media. Transfers were made onto potato dextrose agar to establish pure cultures. Koch's postulates were followed by inoculating pots of flowering plants from a growth chamber with aqueous suspensions from the cultures. Inoculated plants were enclosed in plastic bags for 4 to 6 days. If symptoms developed, the cause of the disease was confirmed by reisolating the organism. For organisms that were pathogenic, the procedure for inoculation, symptom production, and reisolation, were repeated at least three times. Several *Fusarium* sp. obtained from Robin Morrall were also tested for pathogenicity.

RESULTS AND COMMENTS: Koch's postulates and the frequency of isolation from infected plants collected in fields or the presence of a pathogen in infected tissue indicated an *Aureobasidium* sp. was the major cause of blight in coriander. A species of *Ascochyta*, which is the major cause of blossom blight in caraway, also caused blight on coriander, as did *Fusarium avenaceum, F. poae, F. culmorum, F. equiseti, F. sporotrichioides, F. graminearum, Botrytis cinerea* and an unknown non-sporulating fungus. *Fusarium avenaceum* and the unknown non-sporulating fungus were isolated from infected tissue.

Aureobasidium sp. was difficult to isolate from diseased tissue. It was slow growing and easily overgrown by saprophytes that were present in blighted tissue. *Aureobasidium* sp. was isolated by plating disinfected small pieces of recently blighted tissue on water agar. The sparse growth on water agar allows the characteristic growth of *Aureobasidium* sp., that is, whorls of budding spores on hyphae to be seen under a microscope. The fungus was then transferred onto potato dextrose agar where it produced a slimy bacteria-like growth.

In 2000, 22 fields at 10 locations were surveyed between July 24 and 26. None or up to 5% blight, caused by *Aureobasidium* sp., was found at Annaheim, Nokomis, Gerald, Prince Albert, Imperial, Lucky Lake, Eston and Loreburn. Forty to 60% disease incidence was found at Albertville and Meath Park. Blight showed up in many fields as distinct patches. At one location near Meath Park this likely originated from seed as they had never grown the crop before and nor was, or had there been, any coriander grown nearby. One of their fields had about 50% disease but all the rest showed 1 to 5 m^2 patches which covered 1 to 5% of the field. Some fields in other locations showed the effect of spread from a previous nearby crop. Aster yellows was present in all fields at trace amounts.

In 2001, five fields at four locations (St. Denis, Nokomis, Imperial, Gerald) were surveyed between July 19 and 23. No blight was found in any fields. Aster yellows was present at trace levels in one field near Nokomis. Drought stress was the most important problem. Due to the drought, other areas of the province were not surveyed.

In 2002, 12 fields at seven locations were surveyed between July 18 and 24. A trace of blight occurred in the field at Gerald. This was caused by *Ascochyta* sp. likely because it was next to a severely blighted field of caraway where the disease was caused by *Ascochyta* sp. Other areas in the survey were fields near Assiniboia, Moose Jaw, Loreburn, Lucky Lake and Stalwart. There was a trace of aster yellows in two fields, at Imperial and Gerald.

On anise no blight was observed in a field near Eston in 2000. This long season crop is only grown on a limited acreage. Koch's postulates showed blight of anise could be caused by *Aureobasidium* sp., *Ascochyta* sp., *Fusarium avenaceum, F. culmorum, F. equiseti, F. graminearum,* and *F. sporotrichioides*.

On cumin no blight was observed in a plot at Saskatoon in 2002. Cumin is rarely grown because of poor seed production that is suspected to be due to blight. Koch's postulates showed blight of cumin could be caused by *Aureobasidium* sp., *Ascochyta* sp., *Fusarium avenaceum, F. culmorum, F. equiseti , F. graminearum, F. poae , F. sporotrichioides* and *Botrytis cinerea*.

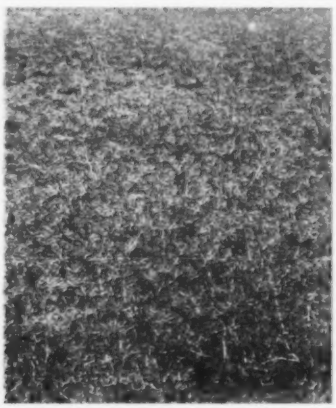
On dill no blight was observed in fields at Prince Albert and Gerald in 2000, and in a field at Gerald in 2001. Koch's postulates showed blight of dill could be caused by *Fusarium avenaceum, F. culmorum* and *F. sporoticihioides*.

ACKNOWLEDGEMENTS: Funding support was provided by the Agriculture Development Fund of the Saskatchewan Agriculture, Food and Rural Revitalization.

BLIGHT DISEASE OF CORIANDER AND CARAWAY IN SASKATCHEWAN

In Saskatchewan, coriander and caraway are affected by a blight that can cause severe losses in these crops. In the diseased caraway field in the photograph on the right, yield loss from blight was over 90%. The disease is also called blossom blight because it mainly kills the flowers.

Healthy caraway field

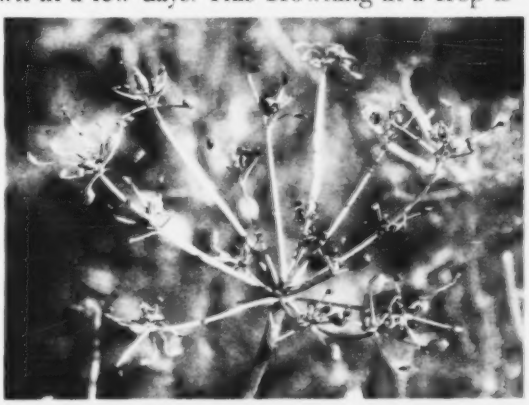


Diseased caraway field

Cause: The most important cause of blight in caraway is an *Ascochyta* sp., while in coriander it is an *Aureobasidium* sp. *Ascochyta* sp. will also cause blight on coriander while *Aureobasidium* sp. will cause blight on caraway. Additional fungal species can cause the same disease on both crops and these are: *Fusarium avenaceum, F. poae, F. culmorum, F. equiseti, F. sporotrichioides, F. graminearum, Botrytis cinerea* and *Sclerotinia sclerotiorum*. The occurrence of persistent wet conditions during flowering could result in any one of these fungi causing blight.

Diseased coriander flowers

Field Scouting: The best time to scout crops for this disease is during flowering. Depending upon the stage of flowering, a healthy field will show the whitish to whitish-pink coloration of the flowers interspersed with the bright green growth of healthy stems, leaves and seeds. Depending upon disease severity, a blighted field may have scattered small patches of brown areas to the whole field being brown. Note the difference in colour between the healthy and diseased caraway fields in the photograph above. Distinct patches of disease may indicate points of inoculation that originated from seed. When the disease is severe a field may turn brown in a few days. This browning in a crop is mainly due to the death of growing tips, flowers and umbels. This damage is illustrated in the two close up photographs. In coriander, note the emerging umbels containing the young flowers that have been killed while in caraway, the small flowers and young seeds have been killed. Later in the season when plants are beginning to mature it may be difficult to recognise a diseased field aside from the reduced seed production.



Diseased caraway flowers →

Suggested Control Measures: There is no simple method for the control of blight. The currently grown types or cultivars show no resistance to blight. Once blight is established in a field or on a farm it will be there for a long time. The following suggestions may lower the risk of severe damage. Weather remains an unpredictable but very important factor, as a prolonged moist period during flowering is very conducive to disease development.

Continuous cropping. Because the disease is more severe in older crops there is a high risk of damage if these crops are grown continuously. For instance, a two-year-old caraway field with a trace of blight will likely be a severely damaged field in the third year.

Coriander underseeded to caraway. The common practise of underseeding coriander with caraway could favour disease development in caraway when it produces seed in the second year because the same pathogens can affect both crops.

Crop rotation. Crop rotation is another control measure but there is no data to suggest how long the interval should be between crops. A guess would be a 2 to 5 year period between the same crop. There are many factors that determine how long the causal agents will survive in a field. For instance, coriander persists as a weed for a long time, which could allow the disease to survive in a field so a longer interval between crops may be needed. Another consideration is that the fusaria, which can cause blight in coriander and caraway also cause fusarium head blight in wheat. So if fusarium head blight was severe in a wheat field it might be appropriate not to seed that field to coriander or caraway the following year.

Field location. Give some thought to field location because a severely diseased crop is a source of inoculum for crops planted in adjacent fields the following year. The inoculum of these diseases can spread across a road allowance but it is unknown if they can spread further.

Disease free seed. Using seed from a field with no disease should reduce the spread to new fields or new areas. Caraway seed could be tested for the presence of pathogens but coriander seed is usually heavily contaminated with saprophytes so a seed test may be inconclusive to determine the presence of pathogens.

Fungicide control. Although fungicide sprays have shown some promise none are currently registered for use on these crops.

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